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मानक

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Mazdoor Kisan Shakti Sangathan

“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 7372 (1995): Lead-acid storage batteries for motor vehicles [ETD 11: Secondary Cells and Batteries]



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक
मोटर वाहनों के लिए सीसा-अम्ल की भंडारण बैटरियाँ —
विशिष्टि
(पहला पुनरीक्षण)

Indian Standard
**LEAD-ACID STORAGE BATTERIES FOR MOTOR
VEHICLES — SPECIFICATION**
(*First Revision*)

First Reprint MAY 1997

UDC 621.355.2 : 629.113

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

AMENDMENT NO. 3 MAY 2007
TO
IS 7372 : 1995 LEAD-ACID STORAGE BATTERIES
FOR MOTOR VEHICLES — SPECIFICATION

(First Revision)

[*Second cover, Foreword, para 5, line 8 (see also Amendment No. 1)*] — Delete the word 'optional'.

[*Second cover, Foreword, para 5, line 12 (see also Amendment No. 1)*] — Substitute 'additional' for 'optional'.

[*Page 4, clause 8.3.1, line 2 (see also Amendment No. 1)*] — Delete the word 'optional'.

[*Page 10, clause heading 9.18 (see also Amendment No. 1)*] — Substitute 'Additional' for 'Optional'.

[*Page 10, clause 9.18.2.1, table heading, col 5 (see also Amendment No. 1)*] — Substitute 'Ratio A:B (percent)' for 'Ratio A:B'.

[*Page 10, clause 9.18.2.1, table, row 1, col 5 (see also Amendment No. 1)*] — Substitute '59' for '5 9'.

[*Page 10, clause 9.18.2.1, table, row 2, col 5 (see also Amendment No. 1)*] — Substitute '60' for '6 0'.

(ET 11)

AMENDMENT NO. 2 SEPTEMBER 2003
TO
IS 7372 : 1995 LEAD-ACID STORAGE BATTERIES
FOR MOTOR VEHICLES — SPECIFICATION

(First Revision)

(Page 2, clause 4.4, and Annex A on page 11) — Substitute 'IS 266 : 1993' for 'IS 266: 1977'.

(Page 2, clause 4.5, and Annex A on page 11) — Substitute 'IS 1069 : 1993' for 'IS 1069 : 1964'.

(Page 5, clauses 9.2.1 and 9.2.2) — Insert the following note at the end of both clauses separately:

'NOTE — Digital/Analog meters may be used.'

(Page 6, clause 9.7.3) — Substitute the following formula for the existing:

$$C_{27} = \frac{C_t}{1 + 0.01 (t - 27)}$$

(ET 11)

AMENDMENT NO. 1 DECEMBER 1996
TO
IS 7372 : 1995 LEAD-ACID STORAGE BATTERIES
FOR MOTOR VEHICLES — SPECIFICATION

(*First Revision*)

(*Second cover page, Foreword*) — Insert the following paragraph after the fourth para:

‘A scheme of labelling environment friendly product with the ECO logo has been introduced at the instance of the Ministry of Environment and Forest (MEF), Government of India. The ECO Mark would be administered by the Bureau of Indian Standards (BIS) under the *BIS Act*, 1986, as per the Resolution No. 71 dated 21 February 1991 and No. 425 dated 28 October 1992 published in the Gazette of the Government of India. For a product to be eligible for marking with ECO logo, it shall also carry the ISI Mark of the BIS besides meeting additional optional environment friendly requirements. For this purpose the Standard Mark of BIS would be a single mark being a combination of the ISI Mark and the ECO logo. Requirements to be satisfied for a product to qualify for the BIS Standard Mark for ECO friendliness, have been included in this standard. These requirements will be optional. Manufacturing units will be free to opt for the ISI Mark alone also.

The success of ECO Mark scheme will largely depend on the availability of used old batteries for recovery/recycling of lead in an environment friendly manner. In order to ensure the availability of used old batteries the necessary arrangement may be made so that large consumers such as Defence, Railways, State Road Transport Corporations, etc, are obliged to return the used/old batteries to the manufacturers or their authorized agents who will undertake recovery of lead by complying with the provisions of *Water (PCP) Cess Act*, 1977, *Air (PCP) Act*, 1981 and *Environment (Protection) Act*, 1986 and the Rules made thereunder.’

(*Page 4*) — Insert the following new clauses after 8.2.2:

‘8.3 ECO Mark

8.3.1 For a product to be eligible for marking with ECO logo, it shall also carry the ISI Mark of the BIS besides meeting additional optional environment friendly requirements. For this purpose the Standard Mark of BIS would be a single mark being a combination of the ISI Mark and the ECO logo. Requirements to be satisfied for a product to qualify for the BIS Standard Mark for ECO friendliness, have been included in 9.18.’

Amend No. 1 to IS 7372 : 1995

(Page 10, clause 9.17.5) — Insert the following new clauses:

“9.18 Optional Requirements for ECO Mark

9.18.1 General Requirements

9.18.1.1 The automotive lead-acid batteries shall meet the relevant standards of Bureau of Indian Standards.

9.18.1.2 The product manufacturer must produce the consent/clearance as per the provisions of *Water (PCP) Act, 1974, Water (PCP) Cess Act, 1977 and Air (PCP) Act, 1981* along with the authorisation if required under *Environment (Protection) Act, 1986* and Rules made thereunder.

9.18.1.3 The product packing may display in brief the criteria based on which the product has been labelled environment friendly.

9.18.1.4 The product may be sold along with instructions for proper use so as to maximise the product performance and safe disposal.

9.18.1.5 The material used for product packing shall be recyclable or biodegradable.

9.18.1.6 The manufacturer shall organize the collections/payback system for the used batteries and provide documentary evidence by way of certificate or declaration to this effect to Bureau of Indian Standards while applying for ECO Mark.

9.18.2 Product Specific Requirements

9.18.2.1 The quantity of lead used, in kg per battery (A) charged battery weight with electrolyte in kg (B) and Ratio A:B shall not exceed the limits given below:

| <i>Sl No.</i> | <i>Type of Battery</i> | <i>Net Lead Content in kg 'A'</i> | <i>Charged Battery Weight with Electrolyte in kg 'B'</i> | <i>Ratio A:B</i> |
|---------------|------------------------|-----------------------------------|--|------------------|
| 1. | 12 V 32 Ah | 6.11 | 10.5 | 5.9 |
| 2. | 12 V 32 Ah | 6.6 | 11.0 | 6.0 |
| 3. | 12 V 50 Ah | 8.36 | 16.0 | 53 |
| 4. | 12 V 60 Ah | 9.96 | 17.5 | 57 |
| 5. | 12 V 75 Ah | 13.75 | 22.5 | 62 |
| 6. | 12 V 110 Ah | 17.17 | 30.2 | 57 |
| 7. | 12 V 120 Ah | 19.32 | 36.0 | 56 |
| 8. | 12 V 135 Ah | 20.91 | 36.3 | 58 |
| 9. | 12 V 150 Ah | 24.8 | 45.0 | 56 |

Amend No. 1 to IS 7372 : 1995

9.18.2.2 Lead used in batteries shall be recovered/manufactured through a process complying under the provisions of *Water (PCP) Act, 1974, Water (PCP) Cess Act, 1977 and Air (PCP) Act, 1981* along with the authorisation if required under *Environment (Protection) Act, 1986* and Rules made thereunder.

NOTE -- The manufacturer of the battery shall obtain documentary evidence from the lead manufacturer to this effect such as consent/clearance from Pollution Control Board and provide the same to BIS while applying for ECO Mark.

9.18.2.3 The manufacturer of 'Oxide' as well as 'Grid' plates of the battery shall ensure full compliance of the provision under *Water (PCP) Act, 1974, Water (PCP) Cess Act, 1977 and Air (PCP) Act, 1981* along with the authorisation if required under *Environment (Protection) Act, 1986* and Rules made thereunder.

NOTE — Manufacturer of the battery shall obtain documentary evidence from the 'Oxide' and 'Grid' manufacturers to this effect such as consent/clearance from Pollution Control Board and provide the same to BIS while applying for ECO Mark.

9.18.2.4 The product shall contain the following percentage of recycled lead (from post-consumer lead) measured over a period of 3 months (as a rolling average) where 100 percent is the total amount of lead contained in the batteries manufactured during the quarter:

- a) Up to 1 year 25 percent, *Minimum*
- b) Up to 2 years 40 percent, *Minimum*
- c) Up to 3 years 50 percent, *Minimum*

NOTE — The manufacturer shall provide documentary evidence by way of certificate or declaration to this effect to Bureau of Indian Standards while applying for ECO Mark."

(ET 11)

Indian Standard

LEAD-ACID STORAGE BATTERIES FOR MOTOR VEHICLES — SPECIFICATION

(First Revision)

1 SCOPE

This standard covers the characteristics, dimensions and tests for lead-acid storage batteries with a rated voltage of 6 or 12 volts, used primarily for engine starting and other electrical loads in vehicles driven by internal combustion engines.

2 REFERENCES

The Indian Standards given in Annex A are necessary adjuncts to this standard.

3 TERMINOLOGY

3.0 For the purpose of this standard, the definitions given in IS 1885 (Part 8) : 1986 in addition to the following shall apply.

3.1 Type Tests

Tests carried out to prove conformity with the requirements of this standard. These are intended to prove the general quality and design of a given type of battery.

3.2 Acceptance Tests

Tests carried out on samples selected from a lot for the purpose of verifying the acceptability of the lot.

3.3 Dry Charged Batteries

A battery intended for use as soon as it has been filled with electrolyte, without any initial charging.

3.4 Fully Charged Cell or Battery

The charging current being that specified by the manufacturer, a battery is considered to be fully charged when its terminal voltage and the specific gravity of its electrolyte do not vary appreciably during two consecutive hours at the end of the charging period, account being taken of temperature variations.

4 MATERIALS, CONSTRUCTION AND WORKMANSHIP

4.1 Container and Lids

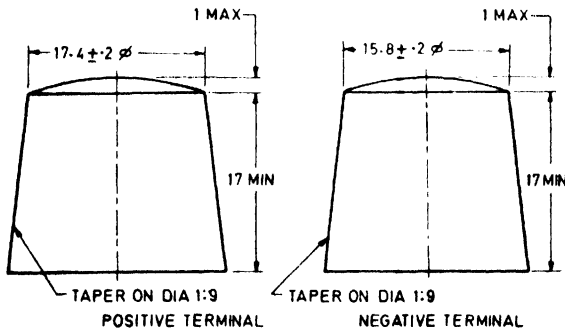
The battery shall be assembled in a monobloc container conforming to IS 1146 : 1981. Each cell shall be fitted with an anti-splash type vent plug or have a venting system that arrests acid spray and splashing of acid without impeding the free escape of gases.

4.2 Sealing Compound

Sealing compound, if bitumen based, shall conform to IS 3116 : 1965.

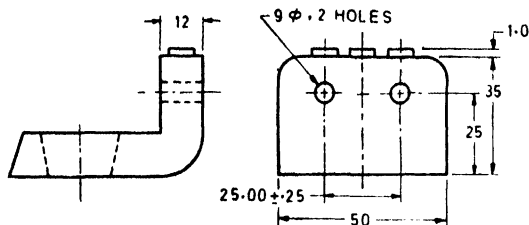
4.3 Terminals

The terminal posts shall conform to either Fig. 1 or Fig. 2. The terminal posts shall bear the indication of polarity on the upper surface in accordance with the alternatives shown in Fig. 3.



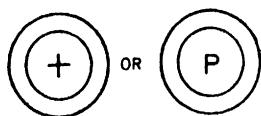
All dimensions in millimetres.

FIG. 1 DIMENSIONS OF TERMINAL POSTS

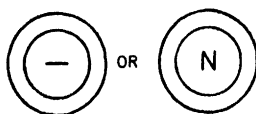


All dimensions in millimetres.

FIG. 2 LUG-TYPE TERMINAL POSTS



POSITIVE TERMINAL



NEGATIVE TERMINAL

FIG. 3 TERMINAL MARKINGS

4.4 Electrolyte

The electrolyte shall be battery grade sulphuric acid conforming to IS 266 : 1977.

4.5 Water

Water for storage batteries conforming to IS 1069 : 1964 shall be used in the preparation of electrolyte and also to bring the level of electrolyte to approximately the correct height during the course of operation or testing.

4.6 Specific Gravity

For the purpose of the tests the specific gravity of the electrolyte with the battery in fully charged condition corrected to a temperature of 27°C shall be 1.280 ± 0.010 .

4.6.1 To correct the specific gravity reading to 27°C:

- add 0.000 7 to the observed hydrometer reading for each °C above 27°C, and
- deduct 0.000 7 from the observed hydrometer reading for each °C below 27°C.

NOTE — Under conditions of normal use, the specific gravity shall be that recommended by the manufacturer.

4.7 Separators

4.7.1 The synthetic separators shall conform to IS 6071 : 1986.

5 RATING

The rating of a starter battery (C_{10}) shall be assigned by the manufacturer and shall be chosen from Tables 1 and 2. It shall be expressed in ampere hours obtainable when the battery is discharged at the 20 hour rate, that is, at a constant current of $I = 0.05 C_{10} A$, until the terminal voltage has fallen to 5.25 V for 6-volt batteries or 10.50 V for 12-volt batteries, the capacity being corrected to an electrolyte temperature of 27°C (see 9.7).

6 CAPACITIES, OVERALL DIMENSIONS AND LAYOUT

6.1 Capacities and corresponding overall dimensions of batteries other than 'special' shall be as given in Table 1.

6.2 Capacities and overall dimensions of 'special' batteries shall be as given in Table 2.

6.3 A suffix shall be added to the dimensional reference to denote the battery layout in accordance with Fig. 4.

7 CHARGING

The first charge and normal charging of batteries shall be done in accordance with the manufacturer's instructions. The following shall be provided with the manufacturers' instructions:

- The last date of filling in and charging; and
- For dry charged batteries, the date of expiry of dry charged condition together with instructions thereafter.

8 MARKING

8.1 The following information shall be legibly and durably marked on each battery:

- Indication of source of manufacturing,

Table 1 Capacities and Overall Dimensions
(Foreword, and Clauses 5.1 and 6.1)

| Designation (Under Consideration) | Capacity Rating C ₁₀ | Overall Maximum Dimensions | | | |
|--|---------------------------------------|----------------------------|-------|---------------------|-------------------|
| | | Length | Width | Container Height | Overall Height |
| (1) | (2) | (3) | (4) | (5) | (6) |
| Ah | mm | mm | mm | mm | mm |
| 6-Volt range | 100 | 235 | 177 | 200 | 225 |
| | 120 | 300 | 177 | 200 | 225 |
| | 135 | 327 | 177 | 215 | 240 |
| | 150 | 350 | 177 | 215 | 240 |
| 12-Volt range | 45 | 260 | 177 | 200 | 225 |
| | 60 | 320 | 177 | 203 | 225 |
| | 75 | 368 | 177 | 215 | 240 |
| | 88 | 430 | 185 | 215 | 240 |
| | 120 | 525 | 225 | 240 | 240 |
| | 135 | 525 | 225 | 240 | 240 |
| | 150 | 525 | 255 | 240 | 240 |
| | 180 | 525 | 295 | 250 | 255 |
| | 190 | 525 | 295 | 250 | 255 |
| | 200 | 525 | 295 | 250 | 255 |

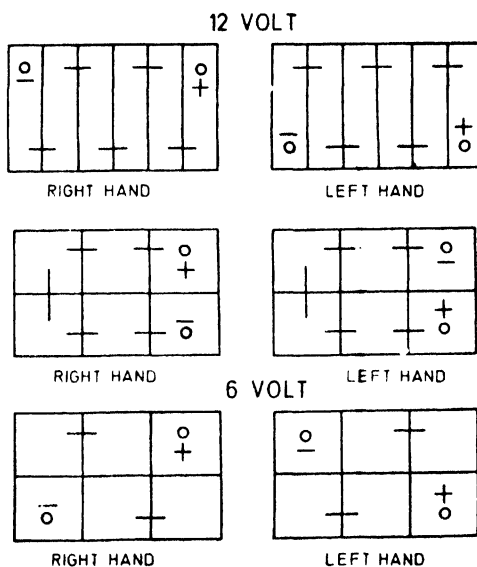


FIG. 4 BATTERY LAYOUT

Table 2 Capacities and Overall Dimensions of Special Batteries
(Foreword, and Clauses 5.1 and 6.2)

| Designation (Under Consideration) | Capacity Rating C ₉₀ | Overall Maximum Dimensions | | | |
|--|---------------------------------------|----------------------------|-------|---------------------|-------------------|
| | | Length | Width | Container Height | Overall Height |
| (1) | (2) | (3) | (4) | (5) | (6) |
| | Ah | mm | mm | mm | mm |
| 6-Volt | 180 | 330 | 195 | 380 | 380 |
| | 190 | 315 | 185 | 370 | 370 |
| | 200 | 385 | 195 | 380 | 380 |

- b) Rated voltage and rated ampere-hour capacity and/or manufacturer's type number,
c) Country of manufacture, and
d) Month and year of manufacture or codes to indicate this.

8.1.1 In addition to the information given in 8.1 the following shall be given with each battery in a label firmly attached to the battery:

- a) Month and year of manufacture;
b) Last date of filling in and charging; and
c) In case of dry charged battery, the date of expiry of dry charged condition together with instructions thereafter.

8.2 BIS Certification Marking

8.2.1 The batteries may also be marked with the Standard Mark.

8.2.2 The use of the Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

9 TESTS

9.1 Classification of Tests

9.1.1 Type Tests

The tests given in 9.1.1.1 shall constitute the type tests.

9.1.1.1 Sequence of tests and samples

The samples shall be drawn at random by the testing or inspecting authority. Six samples shall be tested. The sequence of tests shall be as indicated in the schedule below:

| Test | Battery Number | | | | | |
|--|----------------|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| a) Physical examination (see 9.3) | × | × | × | × | × | × |
| b) Dimensions and layout (see 9.4) | × | × | × | × | × | × |
| c) Marking (see 9.5) | × | × | × | × | × | × |
| d) Air pressure (see 9.6) | × | × | × | × | × | × |
| e) Capacity (see 9.7) | × | × | × | × | × | — |
| f) Vibration (see 9.8) | — | — | — | — | × | — |
| g) High rate discharge at normal temperature (see 9.9) | × | × | × | × | — | — |
| h) High rate discharge at low temperature (see 9.10) | × | × | — | — | — | — |
| j) Retention of charge (see 9.12) | — | — | × | × | — | — |
| k) Resistance to overcharge (see 9.13) | — | — | × | × | — | — |
| m) Life (see 9.14) | × | × | — | — | — | — |
| n) Storage (see 9.15) | — | — | — | — | — | × |

NOTE — In case of dry charged batteries, the tests (a), (b), (c) and (d) followed by the test according to 9.16 shall be carried out prior to the other tests. The battery is to be recharged at the normal rate after the test according to 9.16.

9.1.1.2 If any of the samples fail in the relevant type test, the testing authority may call for fresh samples not exceeding twice the original number and subject them again to the test(s) in which failure occurred. If there is any failure in the retest(s), the type shall be considered as not having passed the requirements of this standard.

9.1.2 Acceptance Tests

The following shall constitute the acceptance tests:

- a) Physical examination (see 9.3),
- b) Dimensions and layout (see 9.4),
- c) Marking (see 9.5),
- d) Air pressure (see 9.6),
- e) Capacity (see 9.7),
- f) High-rate discharge test at normal temperature (see 9.9), and
- g) High-rate discharge test at low temperature (see 9.10).

NOTES

1 The inclusion of high rate discharge test at low temperature shall be subject to agreement between the purchaser and the supplier.

2 In case of dry charged batteries the above tests except (a), (b), (c) and (d) shall be carried out after the test prescribed in 9.16 followed by a recharge at the normal rate. Tests and requirements for special batteries are not applicable in case of dry charged batteries.

9.1.3 Sampling Scheme and Criteria for Acceptance

9.1.3.1 Lot

All the batteries of the same type, design and rating, manufactured by the same factory during the same period using the same process and materials offered for inspection at a time shall constitute a lot.

9.1.3.2 Scale of sampling

The number of batteries to be selected at random from the lot shall be in accordance with col 1 and 2 of Table 3.

In order to ensure the randomness for selection random number tables shall be used (see IS 4905 : 1968).

The batteries selected as in 9.1.3.2 shall be subjected to the acceptance tests in the order specified in 9.1.2.

Each of the battery selected in the first stage in accordance with col 2 of Table 3 shall be tested for acceptance. A battery shall be declared defective if it fails in one or more of the acceptance tests. If the number of defects is less than or equal to C1 the lot shall be considered as conforming to the requirements of the standard. If the number of defectives is equal to or greater than C2 the lot shall be considered as not conforming to the requirements of the standard. If the number of defectives in the first stage is less than C2 and greater than C1, a further sample of same size as taken in the first stage shall be taken and tested. If the number of defectives in the two samples combined is less than C3 the lot shall be considered as conforming to the requirements of this standard otherwise the lot shall be considered as not conforming to the requirements of the standard.

9.2 Equipment

9.2.1 Voltmeter

The voltmeter used shall be of an accuracy class not inferior to at least 0.5 in accordance with IS 1248 (Part 1) : 1983. The resistance of the voltmeter shall be at least 300 ohms per volt.

9.2.2 Ammeters

The ammeter used shall be an accuracy class not inferior to at least 0.5 in accordance with IS 1248 (Part 1) : 1983.

9.2.3 Thermometers

Thermometers used during tests shall have a graduated scale, one division of which shall represent not more than 1°C. The thermometers shall be accurate to within $\pm 0.5^\circ\text{C}$.

Table 3 Sample Size and Criterion for Conformity
(Clause 9.1.3.2)

| Lot Size N | First Stage n | Second Stage n | 2n | C1 | C2 | C3 |
|-----------------|------------------|-------------------|-----|-----|-----|-----|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Up to 50 | 2 | 2 | 4 | 0 | 1 | 1 |
| 51 to 300 | 3 | 3 | 6 | 0 | 1 | 1 |
| 301 to 500 | 5 | 5 | 10 | 0 | 2 | 2 |
| 501 to 1 000 | 8 | 8 | 16 | 0 | 2 | 2 |
| 1 001 and above | 13 | 13 | 26 | 0 | 3 | 4 |

9.2.4 Hydrometers

The specific gravity of the electrolyte shall be measured by hydrometers provided with a graduated scale, one division of which shall represent not more than 0.005 units of specific gravity. The hydrometer shall be accurate to within ± 0.005 units of specific gravity.

9.3 Physical Examination

The batteries shall be examined for conformity with the requirements of 4.

9.4 Dimensions and Layout

The dimensions and layout of the batteries shall be checked for conformity with 6.

9.5 Marking

The batteries shall be examined for conformity with 8.

9.6 Air Pressure Test

The sealing of each cell of the battery shall be checked by compressed air at a pressure equal to 70 cm of water. The volume of tubes and auxiliary parts in connection with the cell under pressure shall not exceed 0.5 litre. Air pressure in the cell shall be noted 15 seconds after the supply has been disconnected. At the end of 15 seconds the level of water in the manometer connected to the cell shall not fall below 67 cm. The air pressure test shall be carried out in dry uncharged condition.

9.7 Capacity Test

The battery shall be first charged according to the manufacturer's instructions and when, fully charged the level and specific gravity of the electrolyte of each cell checked and, if necessary, adjusted. The electrolyte level shall be that recommended by the manufacturer and shall not be less than 6 mm over the top of separators.

9.7.1 Within a period of 2 to 12 hours from the end of charge and with an electrolyte temperature of 20 to 35°C the battery shall be discharged at a constant current of $I = 0.05 C_{10}$ A, until the terminal voltage has fallen to 5.25 V in the case of a 6-volt battery or 10.50 V in the case of a 12-volt battery.

9.7.2 During discharge, the following values shall be checked and noted at suitable intervals:

- a) the battery terminal voltage,
- b) the discharge current, and
- c) the temperature of the electrolyte.

The measurements shall normally be taken hourly; but the voltage shall be checked at

half-hourly intervals when the total battery voltage has fallen below $n \times 1.90$ V, and at 15 minute intervals when the total battery voltage has fallen below $n \times 1.80$ V where n is the number of cells.

9.7.3 The capacity obtained by multiplying the rate of discharge in amperes by the duration of discharge in hours shall be corrected for temperature by the use of the following formula:

$$C_{17} = \frac{C_t}{1 \times 0.01 (t - 27)}$$

where

C_{17} = capacity in Ah at an average electrolyte temperature of 27°C,

C_t = capacity in Ah obtained at an average electrolyte temperature of $t^\circ\text{C}$, and

t = average value in $^\circ\text{C}$ of the initial and final electrolyte temperature measured in the central cell(s).

After discharge the battery shall be recharged at the normal rate.

9.7.4 10-h Rate

Alternatively batteries may be subjected to an equivalent 10-h capacity test, the 10-h rating being calculated according to the following formula:

$$C_{10} = 0.88 C_{20} \text{ at } 27^\circ\text{C}$$

The test shall be carried out in accordance with **9.7.1** and **9.7.3** with a discharge current $I = 0.1 C_{10}$ A.

The battery shall be charged at the normal charging rate immediately after it is discharged.

9.7.5 Requirements

Batteries tested after initial charge according to the manufacturer's instructions shall reach their rated capacity during the course of the first three cycles.

NOTE — If as a result of the first or second test itself, the capacity is found to be equal to or above the rated value, it is not necessary to carry on the test further.

9.8 Vibration Test

The test shall be performed in accordance with IS 2106 (Part 16) : 1971. The samples shall be first tested for capacity test at 20-hour rate before putting into vibration test. The test consists in vibrating the batteries at a frequency of 16 Hz with a total displacement of 5 mm for a period of 2 hours. During vibration the batteries shall be discharged at the 20-hour rate.

9.8.1 Requirements

There shall not be any sudden drop, either in the current or voltage values and there shall be no spillage or leakage of electrolyte during the test.

9.9 High-Rate Discharge Test at Normal Temperature

After the 20-hour (or equivalent 10-hour) rate of discharge in accordance with 9.7 the battery shall be tested at a high-rate of discharge at normal temperature.

9.9.1 The high-rate discharge capacity at normal temperature is determined by a discharge at a constant current of $I = 3C_{10}$ A, the discharge being stopped when the battery terminal voltage has fallen to 4.00 V in the case of a 6-volt battery or 8.00 V in the case of a 12-volt battery.

The initial temperature of the electrolyte measured in the central cell(s) shall be $27 \pm 2^\circ\text{C}$.

During the discharge the terminal voltage shall be taken at 5 to 7 seconds after the start and at 30 second intervals thereafter.

9.9.2 Requirements

The battery tested shall meet the minimum requirements specified in Table 4 for the high-rate discharge at normal temperature.

9.9.3 Requirements for Special Batteries

The battery shall meet the minimum requirements specified in Table 5.

9.10 High-Rate Discharge Test at Low Temperature

The high rate discharge at low temperature shall be preceded by one to three complete C_{10} or C_{10} discharge(s). The high-rate discharge capacity at low temperature is determined by a discharge at a constant current of $I = 3C_{10}$ A, the discharge being stopped when the battery terminal voltage has fallen to 3.00 V in the case of a 6-volt battery or 6.00 V in the case of a 12-volt battery. After discharge the battery shall be recharged at the normal charging rate.

For the test the temperature of the electrolyte in the central cell shall be maintained at $0 \pm 2^\circ\text{C}$ for at least 2 hours.

During the discharge the terminal voltage shall be taken at 5 to 7 seconds after the start and at 30 second intervals thereafter.

9.10.1 Requirements

The battery tested shall meet the minimum requirements specified in Table 6 for the high-rate discharge at low temperature.

9.10.2 Requirements for Special Batteries

The battery tested shall meet the minimum requirements specified in Table 7.

Table 4 Requirements for the High-Rate Discharge at Normal Temperature

(Clause 9.9.2)

| Initial Temperature of the Electrolyte | Discharge Current | Minimum Discharge Time | | Battery Terminal Voltage | | | |
|--|----------------------|---------------------------|----|---------------------------|--------------|-------------|--------------|
| | | | | Initial at 5 to 7 seconds | | Final | |
| | | min | s | 6-volt V | 12-volt V | 6-volt V | 12-volt V |
| 27 ± 2 $^\circ\text{C}$ | A $3C_{20}$ | 5 | 30 | 5.00 | 10.00 | 4.00 | 8.00 |

Table 5 Requirements for the High-Rate Discharge at Normal Temperature for Special Batteries

(Clause 9.9.3)

| Initial Temperature of the Electrolyte | Discharge Current | Minimum Discharge Time | | Battery Terminal Voltage | | | |
|--|----------------------|---------------------------|----|------------------------------|--------------|-------------|--------------|
| | | | | Initial at 5 to 7 seconds | | Final | |
| | | min | s | 6-volt V | 12-volt V | 6-volt V | 12-volt V |
| 27 ± 2 $^\circ\text{C}$ | A $3C_{10}$ | 3 | 30 | 4.50 | 9.00 | 4.00 | 8.00 |

Table 6 Requirements for the High-Rate Discharge at Low Temperature

(Clause 9.10.1)

| Initial Temperature of the Electrolyte | Discharge Current | Minimum Discharge Time | | Battery Terminal Voltage | | | |
|--|-------------------|------------------------|----|---------------------------|-----------|----------|-----------|
| | | | | Initial at 5 to 7 seconds | | Final | |
| | | min | s | 6-volt V | 12-volt V | 6-volt V | 12-volt V |
| °C 0 ± 2 | A $3 C_{20}$ | 4 | 00 | 4.50 | 9.00 | 3.00 | 6.00 |

Table 7 Requirements for the High-Rate Discharge at Low Temperature for Special Batteries

(Clause 9.10.2)

| Initial Temperature of the Electrolyte | Discharge Current | Minimum Discharge Time | | Battery Terminal Voltage | | | |
|--|-------------------|------------------------|----|---------------------------|-----------|----------|-----------|
| | | | | Initial at 5 to 7 seconds | | Final | |
| | | min | s | 6-volt V | 12-volt V | 6-volt V | 12-volt V |
| °C 0 ± 2 | A $3 C_{20}$ | 2 | 30 | 4.20 | 8.40 | 3.00 | 6.00 |

9.11 High-Rate Discharge Test at Normal Temperature for Batteries for Heavy Duty Application

The high-rate discharge capacity at normal temperature for batteries above 75 Ah (for cranking diesel engines) is determined at a constant current of $I = 4.5 C_{10}$ A, the discharge being stopped when the battery terminal voltage has fallen to 3.6 V in the case of a 6-volt battery or 7.2 V in the case of a 12-volt battery.

The initial temperature of the electrolyte measured in the control cell(s) shall be $27 \pm 2^\circ\text{C}$.

During discharge, the terminal voltage shall be taken at 5 to 7 seconds after the start and at 30 second intervals thereafter.

9.11.1 Requirements

The battery tested shall meet the minimum requirements specified in Table 8.

9.12 Retention of Charge Test

The battery shall be fully charged at the current specified by the manufacturer, and the level and specific gravity of the electrolyte in each cell adjusted, if necessary.

9.12.1 The battery shall then be subjected to two consecutive capacity tests in accordance with 9.7 the initial capacity C being calculated as the mean of the two results obtained.

9.12.2 After a complete recharge and cleaning of electrolyte from its surface, the battery is stored for a period of 28 days, without disturbance, at a temperature of $27 \pm 2^\circ\text{C}$.

Table 8 Requirements for the High-Rate Discharge at Normal Temperature for Batteries for Heavy-Duty Application

(Clause 9.11.1)

| Initial Temperature of the Electrolyte | Discharge Current | Minimum Discharge Time | | Battery Terminal Voltage | | | |
|--|-------------------|------------------------|----|---------------------------|-----------|----------|-----------|
| | | | | Initial at 5 to 7 seconds | | Final | |
| | | min | s | 6-volt V | 12-volt V | 6-volt V | 12-volt V |
| °C 27 ± 2 | A $4.5 C_{10}$ | 3 | 00 | 4.5 | 9 | 3.6 | 7.2 |

9.12.3 After 28 days storage the battery is subjected to a capacity test in accordance with 9.7. The value of the capacity measured after storage is denoted by C' .

The loss of capacity S expressed as a percentage is calculated from the following formula:

$$S = \frac{C - C'}{C} \times 100 \text{ percent}$$

9.12.4 Requirement

The loss of capacity shall not exceed 20 percent.

9.13 Resistance to Overcharge Test

9.13.1 The test shall be made on batteries which have successfully passed the tests specified in 9.7, 9.9 and 9.12. No further tests shall be made on batteries after the overcharge test.

9.13.2 The battery shall be charged continuously at a current of $I = 0.1 C_{10}$ A for a period of 100 hours. Throughout this period, the battery shall be immersed in a tank of water, the temperature of which is maintained at $40 \pm 3^\circ\text{C}$. The battery shall be so immersed that the top of the battery case is 25 mm above the water level in the tank. If several batteries are placed in the same tank, a distance of 25 mm shall be maintained between them. The distance between a battery and the sides of the tank shall be at least 25 mm.

9.13.3 When the overcharge is completed the battery shall be left disconnected in the tank of water at $40 \pm 3^\circ\text{C}$ for a period of 68 hours. At the end of this period the battery is subjected without recharging to a high-rate discharge test at the current rate of $I = 3C_{10}$ A.

9.13.4 When the high-rate discharge is completed the battery shall be immediately subjected to the next cycles of overcharge, without previous charging.

Each period of 100 hours charge and 68 hours stand, constitute one overcharge cycle.

The cycle shall be repeated to give a total of 4 overcharge cycles, with 4 high-rate checking discharges for batteries other than special batteries. For special batteries the cycle shall be repeated to give a total of 8 overcharge cycles, with 8 checking high-rate discharges.

9.13.5 Requirement

Each of the 4 high-rate checking discharges shall give a duration not less than 4 minutes before the battery terminal voltage has fallen to 4.00 V for a 6-volt battery or 8.00 V for a 12-volt battery.

9.13.6 Requirements for Special Batteries

Each of the 8 high-rate checking discharges shall give a duration of not less than 2 minutes 30 seconds before the battery terminal voltage has fallen to 4.00 V for a 6-volt battery or 8.00 V for a 12-volt battery.

9.14 Life Test

9.14.1 The life test is carried out on at least two batteries which have successfully passed the tests specified in 9.7, 9.9 and 9.10.

9.14.2 After being fully charged the batteries shall be connected to a circuit which will enable them to be subjected to a series of discharges and charges as follows:

Discharge for one hour at an average current of $I = 0.1 C_{20}$ A.

Charge for five hours at an average current of $I = 0.1 C_{20}$ A.

Throughout the life test cycle, the batteries shall be immersed in a tank of water, the temperature of which is maintained at $40 \pm 3^\circ\text{C}$.

The batteries shall be so immersed that the top of the battery containers shall not be more than 25 mm above the water level in the tank. If several batteries are placed in the same tank, a distance of at least 25 mm shall be maintained between them. The distance between the batteries and the sides of the tank shall also be at least 25 mm.

9.14.3 After each series of 36 discharge and charge cycles, the batteries shall be disconnected from the circuit. They shall be left on open-circuit in the tank for 96 hours. After this open-circuit stand, the batteries shall be subjected to a high-rate discharge at the current shown in Table 9. On completion of this discharge, the batteries shall be fully recharged at the normal rate.

The combination of 36 discharge and charge cycles, the 96-hour open-circuit stand, the high rate discharge and the recharge together constitute one complete unit of life test.

During this test the batteries shall be periodically topped up with pure water so as to maintain the correct electrolyte level. The fully charged specific gravity at each capacity test shall be maintained within limits of 1.28 ± 0.01 , if necessary, by adjustment.

9.14.4 Requirement

The number of life test units shall not be less than 3 and for each of the 3 high-rate checking discharges the discharge duration shall not be less than 4 minutes before the terminal voltages specified in Table 9 are reached.

Table 9 Requirements for Life Test
(Clauses 9.14.3 and 9.14.4)

| Initial Temperature of the Electrolyte | Discharge Current | Minimum Discharge Time | | Final Battery Terminal Voltage | |
|---|----------------------|---------------------------|---|-----------------------------------|--------------|
| | | min | s | 6-volt V | 12-volt V |
| °C | A | | | | |
| 40 ± 3 | 3 C ₂₀ | 4 | 0 | 4'00 | 8'00 |

9.14.5 Requirements for Special Batteries

The number of life test units shall not be less than 6 and for each of the 6 high-rate checking discharges the duration of discharge shall not be less than 2 minutes 30 seconds, before the terminal voltages specified in Table 10 are reached.

9.15 Storage Test

9.15.1 The battery shall be stored in dry uncharged condition for a period of 2 years from the date of manufacture at an ambient temperature of $27 \pm 10^\circ\text{C}$ and a relative humidity not exceeding 90 percent.

9.15.2 Requirement

At the end of the storage period the battery shall meet the requirements of 9.7 and 9.9.

9.16 Storage (for Dry Charged Batteries)

9.16.1 The dry charged battery shall be stored with the manufacturer's seal intact at an ambient temperature of $27 \pm 10^\circ\text{C}$ and a relative humidity not exceeding 90 percent for a period of 365 ± 7 days.

At the end of the storage period the battery shall be tested in accordance with 9.17.

9.16.2 Requirement

The battery tested shall meet the requirements given in Table 11.

9.17 High-Rate Discharge Capacity (Dry Charged Battery)

9.17.1 The battery shall be tested within 60 days of manufacture.

9.17.2 The battery shall be maintained at a temperature of $27 \pm 2^\circ\text{C}$ for 24 hours, prior to the test.

9.17.3 The battery shall then be filled with electrolyte of specific gravity 1.280 ± 0.010 or that specified by the manufacturer. The temperature of the electrolyte before filling in shall be $27 \pm 2^\circ\text{C}$.

9.17.4 Twenty minutes after the completion of filling, the battery shall be discharged at a constant current of $I = 3 C_{20}$ A, the discharge being stopped when the terminal voltage has fallen to 3.00 V in the case of a 6-volt battery or 6.00 V in the case of 12-volt battery.

During discharge, the terminal voltage shall be taken at 5 to 7 seconds from the start and at intervals of 30 seconds thereafter.

9.17.5 Requirements

The battery tested shall meet the requirements specified in Table 11.

Table 10 Requirements for Life Test for Special Batteries
(Clause 9.14.5)

| Initial Temperature of the Electrolyte | Discharge Current | Minimum Discharge Time | | Final Battery Terminal Voltage | |
|---|----------------------|---------------------------|----|-----------------------------------|--------------|
| | | min | s | 6-volt V | 12-volt V |
| °C | A | | | | |
| 40 ± 3 | 3 C ₂₀ | 2 | 30 | 4'00 | 8'00 |

Table 11 Requirements for High-Rate Discharge Capacity
(Dry Charged Batteries)
(Clauses 9.16.2 and 9.17.5)

| Period from Date of Manufacture | Discharge Current | Minimum Discharge Time | | Battery Terminal Voltage | | | |
|---------------------------------|------------------------|------------------------|----|---------------------------|-----------|----------|-----------|
| | | | | Initial at 5 to 7 seconds | | Final | |
| | | min | s | 6-volt V | 12-volt V | 6-volt V | 12-volt V |
| 60 day (Max) | A 3 C ₁₀ | 3 | 00 | 4'00 | 8'00 | 3'00 | 6'00 |
| 365 ± 7 days | 3 C ₁₀ | 2 | 00 | 4'00 | 8'00 | 3'00 | 6'00 |

ANNEX A

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

| IS No. | Title | IS No. | Title |
|---------------------------|---|----------------------------|--|
| 266 : 1977 | Specification for sulphuric acid (<i>second revision</i>) | 1885 (Part 8) : 1986 | Electrotechnical vocabulary : Part 8 Secondary cells and batteries (<i>first revision</i>) |
| 652 : 1973 | Specification for caustic soda, pure and technical | 2106 (Part 16) : 1971 | Environmental tests for electronic and electrical equipment : Part 16 Vibration test |
| 1069 : 1964 | Specification for water for storage batteries (<i>revised</i>) | | |
| 1146 : 1981 | Specification for rubber and plastic containers for lead-acid storage batteries (<i>second revision</i>) | 3116 : 1965 | Specification for sealing compound for lead-acid batteries |
| 1248 (Part 1) : 1983 | Direct acting indicating analogue electrical measuring instruments and their accessories : Part 1 General requirements (<i>second revision</i>) | 4905 : 1968 | Methods for random sampling |
| | | 6071 : 1986 | Specification for synthetic separators for lead-acid batteries (<i>first revision</i>) |

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